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PENSOFT

The ichthyofauna of the Moksha River, a tributary of the Volga river basin, Russia

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Abstract
The results of an 11-year study of the ichthyofauna in the Moksha River (central part of European Russia) are described here. Thirty-seven species were recorded, including 34 present in rivers and 26 in lake systems. Relative abundance and the occurrence of fish species from different types of water bodies are provided and the diversity of the ichthyofauna for this region is discussed.

Key words
Diversity; fish; lakes; Oka River.

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Introduction

The Moksha River is one of the largest tributaries of the Oka River drainage, and the largest right-bank tributary of the Volga river basin. As a result, there is fragmentary information on the diversity of ichthyofauna in this basin.

Although this region of Russia is densely populated, the ichthyofauna of the Moksha River was not deeply studied by any recent long-term integrated research project. The first main studies about the fish diversity of the Moksha River were by Magnitskii (1928a, 1928b), which recorded species from the Penza province and documented the differences between the ichthyofauna of Moksha and the adjacent Sura River. Posteriorly, a more detailed study in this same region was conducted by Dushin (1967, 1978), in a period that saw a massive degradation in many Russian rivers caused by pollution. More recently, a great number of unconnected studies in local journals were published (Artaev et al. 2013, Kuznetsov and Barkin 2003, Lysenkov et al. 2010, Lysenkov and Pjanov 2015) with some level of information of fish diversity for this region, but they did not provide a complete scenario of fish abundance and distribution extension of the species in the Moksha river basin. The goals of this study were to assess the diversity, occurrence, distribution extension, and abundance of fish species in different types of water systems to the Moksha river basin.

Materials and Methods

Study site. The Moksha River is situated on the Russian plains between altitudes of 80 to 270 m. The river comprises about 656 km and drains an area of 51,000 km^2. The Moksha River is a plain-type river. Precipitation in the drainage's southern area is approximately 475 mm per year but in the northern portion it can reach up to 500 mm (Yamashkin 1998). The monthly average runoff of

Figure 1. Sampling sites. **A.** Skachki River, locality classified at a distance of 25 km from the source river. **B.** Aza River, locality classified at a distance of 26–100 km from the source river. **C.** Middle reach of Moksha River, locality classified at a distance of 101–300 km from the source river. **D.** Lower reach of Moksha River, locality classified at a distance of 301–500 km from the source river.

rivers in the Moksha drainage varies throughout the year. Low-water periods are in the summer/fall and winter periods, and 70% of the annual runoff is during the spring flood (Mil'kov 1981). Melting snow is the major source feeding the rivers in this region, while groundwater run-off accounts for about 24% and precipitation in the form of rain account for just 5%. The average air temperature of the warmest month (July) is 20 °C and of the coldest month (January), –12 °C. (Mil'kov 1981).

Data collection. A total of 34,716 individual were collected between 2004 to 2015, using seine net (6 m × 1.25 m, 6 mm between knots and 10 m × 1.25 m, 8 mm between knots, but 6 mm in the pocket), dip net (1 m × 1 m of frame; 1.5 m pocket length, 6 mm of mesh size), and stake gill nets (30 m × 1.5 m, 1.7, 3.0, and 5.0 cm between knots). Specimens were fixed in 10% formalin and preserved in 70% alcohol, and posteriorly identified using the identification keys of Kottelat and Freyhof (2007). Taxonomic nomenclature is following Eschmeyer (2017). Specimens were captured under the permits of Federal Fishery Agency No. 348 on extraction of aquatic biological resources YP No. 035786. Collected fishes were cataloged in the Ichthyological Collection of Mordovian State Nature Reserve. A list of species sampled in this study and its catalog number are listed in Table 1. The samples and the geographic coordinates of locations are provided in Table 2.

Data analysis. The habitats over the Moksha River and other water systems where the specimens were collected were categorized according to the physiognomy of the system and then classified into distinct groups according to the distance range of the sampling site from the source of the river 0–25 (Fig. 1A), 26–100 (Fig. 1B), 101–300 (Fig. 1C), and 301–500 km (Fig. 1D), which was calculated using freely available topographic maps at a scale of 1:200 000. The categorization of those water bodies that do not represent the category "rivers" in this study included flowing and landlocked oxbows, karst and suffusion lakes, ponds, and storage reservoirs (Fig. 2). Landlocked oxbows: lakes isolated from the river but periodically connected to it during spring floods; they vary from 0.2 to 45 ha in area and are from 2 to 10 m deep (Fig. 2A, B). Flowing oxbows: lakes permanently connected to the river either directly or via a tributary of the main river; these lakes are 0.9–17.4 ha in area and 3–8 m deep (Fig. 2C). Karst and suffusion lakes: resulted from collapse or subsidence of the terrain; they are few in number and do not have a direct connection to the river;

Table 1. List of species examined in this study and the correspondent cataloged number of vouchers at the Ichthyological collection of Mordovian state reserve.

Species	Catalog number
Petromyzontidae	
Eudontomyzon mariae	P-285, P-286, P-287, P-288, P-289, P-290, P-291, P-358
Esocidae	
Esoxlucius	P-28, P-46, P-70, P-72, P-73, P-75, P-88, P-110, P-145, P-148, P-155, P-162, P-67, P-173, P-179, P-192, P-194, P-196, P-198, P-225, P-249, P-300, P-307, P-313, P-316, P-319, P-326, P-333, P-43, P-353, P-354, P-359, P-361, P-365, P-366, P-73, P-377, P-381, P-393, P-394, P-395, P-406, P-427, P-429, P-431, P-432, P-443, P-481, P-494, P-495, P-503, P-512, P-539, P-550, P-54
Cyprinidae	
Abramis brama	P-26, P-31, P-151, P-157, P-182, P-188, P-198, P-220, P-231, P-241, P-273, P-294, P-295, P-306, P-13, P-341, P-387, P-403, P-427, P-431, P-439, P-489, P-503, P-520, P-543, P-550
Alburnoides rossicus	P-9, P-10, P-11, P-145, P-154, P-156, P-163, P-173, P-179, P-183, P-189, P-203, P-221, P-227, P-242, P-245, P-247, P-255, P-306, P-310, P-324, P-331, P-340, P-349, P-351, P-356, P-361, P-374, P-375, P-379, P-380, P-388, P-402, P-408, P-427, P-503, P-515
Alburnus alburnus	P-26, P-30, P-37, P-38, P-51, P-70, P-71, P-73, P-78, P-107, P-108, P-109, P-113, P-123, P-144, P-147, P-150, P-152, P-159, P-164, P-169, P-171, P-172, P-174, P-176, P-179, P-180, P-184, P-188, P-190, P-192, P-193, P-195, P-196, -197, P-198, P-199, P-200, P-201, P-225, P-238, P-241, P-242, P-243, P-44, P-246, P-298, P-304, P-305, P-309, P-313, P-316, P-318, P-321, P-322, P-330, P-333, P-335, P-337, P-341, P-344, P-349, P-351, P-360, P-361, P-362, P-365, P-366, P-370, P-371, P-75, P-376, P-381, P-382, P-383, P-385, P-394, P-395, P-400, P-402, P-404, P-408, P-413, P-425, P-431, P-37, P-439, P-481, P-489, P-497, P-499, P-504, P-506, P-517, P-543, P-549, P-550, P-553, P-554
Aspius aspius	P-76, P-162, P-168, P-227, P-239, P-273, P-409, P-503
Ballerus ballerus	P-487
Ballerus sapa	P-151
Blicca bjoerkna	P-38, P-108, P-110, P-114, P-148, P-151, P-157, P-168, P-177, P-182, P-185, P-188, P-194, P-198, P-223, P-239, P-273, P-305, P-316, P-317, P-377, P-382, P-387, P-403, P-409, P-425, P-427, P-431, P-439, P-489, P-497, P-498, P-532, P-550
Carassius carassius	P-292, P-297, P-302, P-377, P-426, P-445, P-495, P-498, P-513, P-551
Carassius gibelio	P-50, P-190, P-199, P-296, P-302, P-304, P-329, P-333, P-348, P-354, P-355, P-369, P-386, P-391, P-426, P-428, P-438, P-440, P-441, P-445, P-446, P-447, P-482, P-490, P-492, P-507, P-513, P-517, P-521, P-533, P-536, P-549, P-551
Chondrostoma variabile	P-151, P-168, P-220, P-227, P-239, P-273, P-306, P-403, P-409, P-496
Cyprinus carpio	P-521
Rhynchocypris percnurus	P-14, P-19, P-47, P-109, P-284, P-316, P-317, P-319, P-328, P-359, P-373, P-386, P-393, P-28, P-429, P-460, P-482, P-488, P-518
Gobio volgensis	P-15, P-22, P-27, P-43, P-71, P-73, P-75, P-106, P-114, P-123, P-30, P-139, P-145, P-151, P-156, P-162, P-167, P-182, P-188, P-196, P-197, P-201, P-225, P-227, P-241, P-247, P-249, P-301, P-303, P-305, P-312, P-321, P-22, P-326, P-329, P-332, P-335, P-336, P-343, P-344, P-348, P-349, P-350, P-351, P-353, P-354, P-356, P-357, P-360, P-361, P-362, P-366, P-367, P-369, P-372, P-374, P-375, P-378, P-381, P-384, P-393, P-395, P-398, P-399, P-401, P-402, P-404, P-407, P-413, P-425, P-438, P-481, P-501, P-512, P-515, P-546
Leucaspius delineates	P-50, P-70, P-72, P-73, P-144, P-162, P-178, P-179, P-183, P-185, P-194, P-197, P-200, P-201, P-225, P-301, P-304, P-312, P-313, P-315, P-316, P-325, P-326, P-327, P-333, P-335, P-336, P-344, P-345, P-346, P-348, P-354, P-355, P-356, P-357, P-359, P-360, P-364, P-365, P-366, P-369, P-370, P-372, P-373, P-375, P-377, P-378, P-381, P-386, P-391, P-393, P-394, P-398, P-400, P-406, P-407, P-426, P-429, P-431, P-432, P-438, P-440, P-441, P-442, P-445, P-446, P-447, P-448, P-449, P-450, P-476, P-490, P-505, P-507, P-517, P-532, P-537, P-539, P-544, P-546, P-553, P-5
Squalius cephalus	P-107, P-144, P-145, P-148, P-155, P-162, P-168, P-170, P-182, P-190, P-199, P-200, P-201, P-220, P-222, P-225, P-231, P-241, P-249, P-344, P-354, P-360, P-362, P-365, P-366, P-367, P-383, P-384, P-394, P-395, P-407, P-408, P-409, P-413, P-425, P-427, P-439, P-481, P-489, P-501, P-503, P-506, P-549, P-553, P-555
Leucis cusidus	P-73, P-76, P-108, P-144, P-145, P-148, P-155, P-162, P-170, P-182, P-184, P-197, P-301, P-305, P-356, P-372, P-383, P-401, P-409, P-425, P-492, P-501, P-503, P-506, P-550
Leucis cusleuciscus	P-26, P-28, P-30, P-31, P-36, P-38, P-51, P-78, P-108, P-114, P-122, P-30, P-137, P-145, P-151, P-155, P-162, P-167, P-170, P-178, P-183, P-185, P-190, P-194, P-195, P-197, P-198, P-200, P-220, P-223, P-225, P-241, P-245, P-247, P-249, P-273, P-300, P-306, P-326, P-335, P-336, P-341, P-345, P-350, P-351, P-353, P-357, P-358, P-360, P-362, P-366, P-367, P-369, P-370, P-372, P-75, P-378, P-383, P-395, P-400, P-401, P-407, P-408, P-409, P-413, P-425, P-427, P-429, P-438, P-481, P-500, P-503, P-506, P-553, P-554, P-555
Pelecus cultratus	P-151, P-412
Rhodeus amarus	P-26, P-29, P-107, P-114, P-122, P-162, P-165, P-167, P-170, P-178, P-185, P-195, P-198, P-200, P-201, P-220, P-221, P-305, P-308, P-317, P-320, P-334, P-336, P-344, P-348, P-355, P-65, P-366, P-369, P-375, P-377, P-383, P-386, P-391, P-394, P-395, P-409, P-413, P-425, P-429, P-441, P-51, P-481, P-501, P-503, P-506, P-517, P-554
Romanogobio albipinnatus	P-27, P-106, P-109, P-151, P-156, P-167, P-197, P-222, P-247, P-273, P-306, P-322, P-341, P-409, P-427, P-481, P-501, P-554
Rutilus rutilus	P-30, P-38, P-50, P-51, P-70, P-77, P-106, P-109, P-113, P-122, P-139, P-144, P-146, P-149, P-153, P-158, P-164, P-67, P-171, P-173, P-174, P-175, P-179, P-182, P-185, P-188, P-190, P-191, P-193, P-195, P-196, P-198, P-200, P-201, P-203, P-225, P-237, P-240, P-244, P-248, P-249, P-297, P-299, P-306, P-307, P-308, P-309, P-312, P-313, P-314, P-315, P-316, P-321, P-322, P-326, P-331, P-332, P-338, P-339, P-342, P-344, P-349, P-350, P-351, P-352, P-353, P-357, P-358, P-359, P-360, P-361, P-62, P-366, P-368, P-370, P-371, P-375, P-376, P-381, P-382, P-387, P-389, P-390, P-393, P-394, P-395, P-400, P-402, P-404, P-406, P-407, P-408, P-413, P-425, P-429, P-431, P-437, P-442, P-448, P-449, P-51, P-481, P-489, P-494, P-497, P-498, P-501, P-503, P-506, P-507, P-512, P-517, P-522, P-536, P-537, P-543, P-545, P-548, P-550, P-553, P-554, P-555

Continued

Table 1. *Continued.*

Species	Catalog number
Scardinius erythrophthalmus	P-114, P-148, P-162, P-178, P-239, P-241, P-273, P-297, P-301, P-304, P-308, P-313, P-395, P-427, P-439, P-442, P-452, P-489, P-494, P-497, P-498, P-500, P-519, P-543, P-544, P-549
Tinca tinca	P-73, P-296, P-549
Nemacheilidae	
Barbatula barbatula	P-22, P-36, P-45, P-46, P-70, P-75, P-185, P-199, P-201, P-203, P-245, P-249, P-300, P-309, P-311, P-314, P-321, P-327, P-329, P-332, P-340, P-343, P-345, P-47, P-348, P-349, P-350, P-351, P-356, P-357, P-358, P-360, P-362, P-364, P-366, P-369, P-370, P-372, P-376, P-378, P-381, P-382, P-384, P-389, P-393, P-396, P-397, P-398, P-399, P-401, P-402, P-405, P-410, P-411, P-413, P-425, P-447, P-481, P-512, P-545
Cobitidae	
Cobitis melanoleuca	P-225
Cobitis taenia	P-28, P-29, P-31, P-46, P-47, P-70, P-72, P-75, P-88, P-137, P-144, P-145, P-62, P-166, P-194, P-196, P-243, P-273, P-425, P-436, P-439, P-444
Misgurnus fossilis	P-29, P-384, P-396, P-398, P-411, P-432, P-467, P-510
Siluridae	
Silurus glanis	P-30, P-198
Lotidae	
Lota lota	P-46, P-72, P-75, P-185, P-225, P-321, P-332, P-393, P-404, P-411, P-512
Percidae	
Gymnocephalus cernuus	P-13, P-36, P-71, P-73, P-76, P-118, P-151, P-155, P-167, P-177, P-186, P-194, P-201, P-203, P-225, P-247, P-249, P-297, P-313, P-335, P-401, P-408, P-489, P-501, P-503, P-523, P-549
Perca fluviatilis	P-47, P-50, P-70, P-71, P-72, P-76, P-108, P-110, P-113, P-148, P-162, P-168, P-179, P-181, P-187, P-192, P-194, P-195, P-196, P-198, P-221, P-225, P-241, P-273, P-294, P-300, P-304, P-305, P-307, P-308, P-312, P-313, P-315, P-319, P-323, P-326, P-331, P-339, P-343, P-349, P-359, P-365, P-370, P-377, P-382, P-388, P-393, P-395, P-396, P-402, P-407, P-429, P-431, P-438, P-444, P-448, P-449, P-489, P-494, P-495, P-497, P-498, P-501, P-503, P-506, P-520, P-523, P-532, P-536, P-539, P-543, P-545, P-549, P-550
Sander lucioperca	P-221
Odontobutidae	
Perccottus glenii	P-20, P-307, P-315, P-316, P-317, P-319, P-328, P-340, P-348, P-355, P-356, P-373, P-377, P-392, P-396, P-411, P-428, P-429, P-430, P-432, P-434, P-440, P-443, P-445, P-460, P-467, P-482, P-491, P-492, P-495, P-505, P-510, P-533, P-552

Table 2. Geographic coordinates of the sampling fishes cataloged at Ichthyological Collection of Mordovian State Reserve.

Samples	Latitude (N)	Longitude (E)
P-517, P-521, P-522, P-523	53°40'06"	43°07'05"
P-476	54°51'10"	43°51'10"
P-548, P-549	53°47'33"	43°44'12"
P-186, P-187, P-188, P-292, P-294, P-295, P-296, P-297, P-313	52°33'33"	41°35'32"
P-20, P-284, P-428	54°43'04"	43°13'35"
P-498	53°15'24"	41°44'33"
P-488	54°43'19"	43°14'54"
P-330	54°26'52"	42°40'46"
P-315	54°25'10"	42°14'49"
P-316	54°26'41"	42°29'36"
P-317	54°15'01"	43°47'32"
P-319, P-552	54°09'15"	43°47'54"
P-373	54°34'53"	43°47'55"
P-377	54°40'13"	42°00'01"
P-391	54°25'04"	41°58'25"
P-308	54°26'52"	42°40'46"
P-307	54°38'27"	43°30'49"
P-443	54°29'37"	42°37'38"
P-386, P-392	54°31'23"	42°29'31"
P-550	53°52'49"	44°22'17"
P-430, P-432	54°01'58"	44°03'08"
P-482	54°38'58"	43°13'36"
P-494, P-539	54°43'37"	42°09'03"
P-328	54°40'40"	42°32'49"
P-510	54°45'07"	43°04'60"
P-536	52°30'47"	41°27'43"
P-543, P-544	53°34'28"	41°57'52"
P-431, P-452, P-489	54°43'42"	43°00'56"
P-339	54°40'04"	42°49'14"
P-434	53°59'03"	44°19'40"

Samples	Latitude (N)	Longitude (E)
P-518	54°35'31"	42°32'26"
P-505	54°34'59"	42°34'51"
P-519, P-520	52°41'27"	41°32'03"
P-426, P-551	53°57'10"	43°56'17"
P-355	54°04'23"	43°58'38"
P-442	54°42'20"	42°42'29"
P-302	53°15'45"	44°16'18"
P-495	54°52'18"	43°27'07"
P-532	52°34'60"	41°58'26"
P-438	53°34'41"	44°00'52"
P-447	54°17'27"	43°42'44"
P-449	54°25'05"	43°31'51"
P-440	53°58'50"	44°20'39"
P-441	53°49'28"	43°32'08"
P-446	53°56'21"	43°55'10"
P-490, P-491	53°59'05"	43°46'45"
P-450	53°55'22"	44°26'30"
P-445	53°46'30"	44°45'21"
P-537	52°39'35"	42°04'48"
P-507	53°19'38"	42°15'02"
P-448	54°04'44"	44°25'45"
P-350, P-512	54°06'01"	41°57'28"
P-288	0°0'0"	0°0'0"
P-397	53°18'53"	44°23'58"
P-318, P-357	54°16'28"	41°51'50"
P-364	54°14'47"	41°42'09"
P-199	53°27'24"	43°55'53"
P-401	53°10'17"	44°05'05"
P-436, P-481	53°35'15"	43°54'04"
P-381	52°34'48"	41°19'28"
P-396	54°10'46"	43°42'23"
P-200	52°56'41"	42°04'42"

Continued

Table 2. *Continued.*

Samples	Latitude (N)	Longitude (E)
P-383, P-388, P-390	53°09'47"	42°01'46"
P-10, P-9	54°08'17"	42°35'49"
P-155, P-156, P-157, P-158, P-159	54°12'01"	42°37'23"
P-162, P-163, P-164, P-37	53°50'52"	42°44'13"
P-240, P-241, P-255	54°3'12"	42°39'21"
P-375 P-515	53°42'39"	42°53'59"
P-389	53°33'47"	43°08'20"
P-427, P-429, P-437, P-439, P-444, P-487 P-487	54°29'54"	42°36'58"
P-506	53°54'27"	42°41'06"
P-51	54°10'40"	42°36'17"
P-11	54°20'06"	42°41'28"
P-398	54°34'27"	43°58'49"
P-139, P-196	54°49'47"	42°49'14"
P-332	55°00'47"	42°43'19"
P-309, P-310	54°16'19"	42°53'55"
P-352, P-356	54°12'16"	43°06'46"
P-333	53°46'13"	41°37'10"
P-165, P-166, P-170, P-171, P-174, P-237, P-238, P-239, P-425	53°48'27"	42°17'55"
P-170, P-171	53°32'4"	42°40'11"
P-174	53°23'3"	42°51'04"
P-344	53°54'04"	42°09'38"
P-394	53°57'07"	42°06'48"
P-287, P-345	53°37'11"	44°06'12"
P-322, P-324	54°42'34"	42°24'03"
P-378	54°05'11"	42°12'17"
P-351	53°59'41"	42°08'33"
P-314	53°06'37"	41°10'52"
P-201, P-46	53°51'20"	44°41'39"
P-353	53°49'41"	44°55'35"
P-75, P-76, P-77, P-78	53°52'37"	44°23'31"
P-184, P-185	52°20'48"	41°23'60"
P-384	53°44'31"	43°40'15"
P-180, P-181, P-182, P-183	53°22'54"	41°57'29"
P-374, P-400	53°9'8"	42°15'52"
P-369	53°26'55"	44°20'11"
P-285	53°36'32"	44°01'01"
P-367, P-376	53°53'08"	42°6'12"
P-179	52°58'51"	41°55'15"
P-408	52°34'48"	41°19'28"
P-410	54°30'09"	44°4'27"
P-331	53°46'58"	42°42'46"
P-327, P-546	53°41'31"	42°48'03"
P-354	54°17'39"	43°43'44"
P-198	52°31'06"	41°32'04"
P-312, P-325	54°21'11"	42°09'23"
P-402	54°37'55"	42°23'50"
P-362	53°30'19"	43°37'01"
P-405	53°57'47"	42°50'42"
P-320, P-334, P-335, P-342	53°10'20"	43°55'07"
P-189, P-190	53°00'07"	42°05'27"
P-372	52°56'36"	42°17'54"
P-380, P-413	53°07'34"	42°01'29"
P-291	53°25'60"	43°54'54"
P-108	54°29'50"	42°02'17"
P-109, P-110, P-38	54°45'19"	42°43'50"
P-151, P-152, P-153, P-154	54°45'33"	43°02'06"
P-167, P-168, P-169	54°29'27"	43°49'57"
P-220, P-221, P-231, P-242, P-137	54°04'23"	43°58'38"
P-222, P-223	54°40'20"	43°43'51"
P-227	54°46'14"	42°50'07"
P-246, P-247, P-248	53°51'45"	43°44'51"
P-26, P-44	54°04'19"	44°02'25"
P-273	54°41'39"	43°39'04"
P-290	53°28'33"	44°27'50"
P-305, P-306, P-554	54°30'40"	42°30'32"

Samples	Latitude (N)	Longitude (E)
P-341	54°26'41"	42°29'36"
P-360	53°36'07"	44°19'52"
P-371	54°15'09"	43°47'02"
P-385, P-409, P-412	54°44'26"	41°55'48"
P-395, P-403	54°40'13"	42°00'01"
P-47	54°35'26"	43°12'25"
P-553	54°44'40"	43°05'09"
P-27, P-28	54°40'22"	43°43'49"
P-286	53°32'41"	44°22'48"
P-358	53°32'40"	44°22'48"
P-191, P-192	52°31'14"	41°34'04"
P-366	53°35'43"	43°31'13"
P-311	54°44'22"	43°43'24"
P-326	53°13'43"	42°47'27"
P-348	53°57'57"	43°46'32"
P-361	54°02'48"	43°06'46"
P-70, P-72, P-88	53°54'10"	44°32'23"
P-71, P-73	53°50'27"	44°34'07"
P-298, P-299, P-301	53°34'14"	41°38'38"
P-359	54°20'23"	43°53'11"
P-406	54°13'57"	42°55'40"
P-193, P-194	54°51'48"	42°56'53"
P-300	54°56'16"	42°57'33"
P-13, P-14, P-15	54°49'51"	43°08'07"
P-197	54°48'46"	43°07'31"
P-393	54°57'29"	43°33'12"
P-555	54°55'55"	43°25'15"
P-50	53°59'16"	44°07'09"
P-244, P-245	53°39'05"	41°42'58"
P-144	54°13'57"	44°33'06"
P-145, P-146, P-147	54°21'08"	44°15'10"
P-148, P-149, P-150	54°25'34"	43°59'54"
P-172, P-173	54°19'29"	44°24'50"
P-289, P-329	53°26'55"	44°20'11"
P-365, P-387	52°31'48"	41°05'29"
P-45	53°51'37"	44°45'19"
P-382	52°29'46"	41°25'24"
P-340	54°28'15"	42°39'40"
P-545	53°54'33"	42°40'52"
P-411	54°22'15"	42°24'57"
P-22, P-225	54°41'35"	43°50'36"
P-243, P-249	54°44'17"	43°53'59"
P-106, P-107	54°06'34"	42°05'56"
P-113, P-114	53°03'07"	41°32'27"
P-122, P-123	52°20'44"	41°33'09"
P-175, P-176, P-177, P-178	52°18'32"	41°39'37"
P-321	52°13'17"	41°38'55"
P-497, P-499, P-500, P-501	53°42'60"	41°48'20"
P-503, P-504	53°51'50"	41°50'23"
P-195	53°11'38"	41°28'54"
P-336, P-337, P-368	52°51'13"	41°13'57"
P-467	54°47'56"	43°08'41"
P-343	54°00'01"	42°59'15"
P-323	54°03'05"	41°40'38"
P-407	53°51'36"	43°41'20"
P-399	54°46'23"	42°31'51"
P-349	54°13'55"	43°26'12"
P-379, P-404	54°14'25"	43°10'10"
P-303, P-304, P-338	53°15'10"	42°40'22"
P-346	54°40'21"	42°49'44"
P-203	54°24'25"	42°52'04"
P-36	54°22'40"	43°12'10"
P-460	54°52'07"	43°24'56"
P-513	53°40'28"	42°37'09"
P-533	52°41'28"	41°44'15"

Figure 2. Reservoirs sites. **A.** Large landlocked oxbow in the floodplain Atmis River. **B.** Lake Vertyachka, small landlocked oxbow in the floodplain Moksha River. **C.** Lake Mordovskoe, streaming oxbow in the floodplain Moksha River. **D.** Lake Morskoy Glaz at karst origin. **E.** Pond in Tambov oblast. **F.** Vadinskoe storage reservoir, view from the plane to a height of 5 km.

2–10 m deep and from 1.5 to 30 ha in area (Fig. 2D). Retention ponds: small man-made water bodies having a volume up to 1,000,000 m^3 (1.2–100 ha; Fig. 2: E). Reservoirs: over 1,000,000 m^3 (187–1090 ha; Fig. 2F).

The occurrence of species was calculated as $a \times 100/b$, where a is the number of water bodies where the species was recorded and b, the total number of examined water bodies. The mean shared in catch is the arithmetic mean for the relative sharing in catch calculated for the water bodies where a species was collected.

Results

The list of species, its abundance and distribution (Fig. 3) are briefly described below. The sympatric occurrence of species and rate occurrence in different water systems are shown in Table 3.

Family Petromyzontidae

Eudontomyzon mariae (Berg, 1931), Ukrainian Brook Lamprey

Lampetra mariae Berg 1931: 94.

Eudontomyzon mariae—Levin et al. 2016: 64.

Material examined. Table 1.

Presence of a bicuspid endolateral tooth and spade-like caudal fin. This species was found in the southeastern portion of the Moksha River, which is the northeastern extent of the species' range. The Moksha River is one of the few tributaries of the Volga River drainage where this species inhabits (Artaev et al. 2013). During spring spawning, this lamprey is observed on almost all pebble shoals in the upper reaches of the Moksha River and its tributaries (Fig. 4).

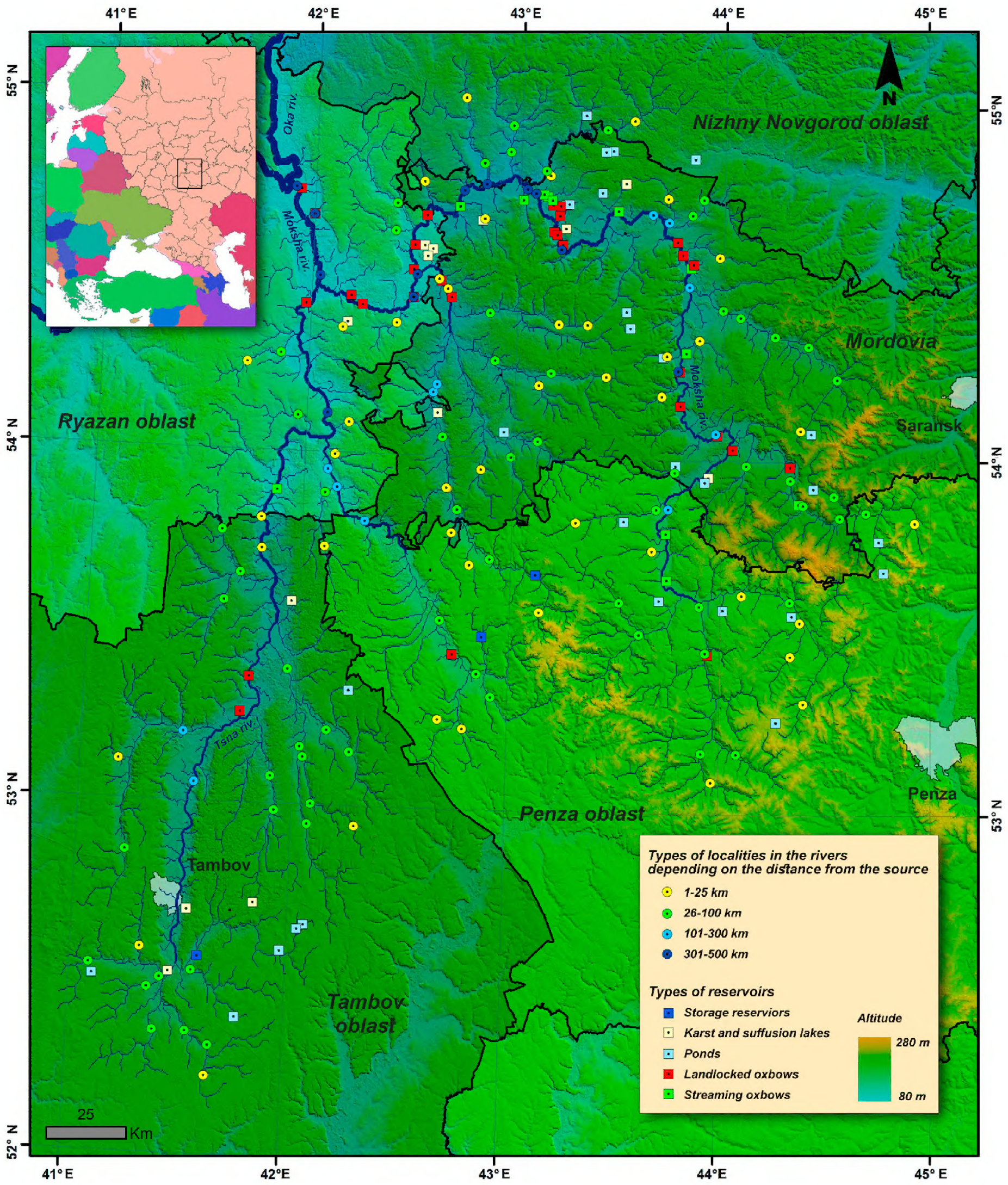

Figure 3. Map of sampled sites, middle European part of Russia, Moksha river basin.

Family Acipenseridae

Acipenser ruthenus Linnaeus, 1758, Sterlet Sturgeon.

Acipenser ruthenus Linnaeus 1758: 237—Kottelat and Freyhof 2007: 55.

Material examined. Table 1; Fig. 5.

Presence of 56–71 lateral plates and first dorsal plate not fused to the head. It was not collected in this study, but was observed in the middle and upper reaches of the Moksha River on a regular basis (Kuznetsov et al. 2008, Lysenkov and Pjanov 2015) (Fig. 5). Over the last decade, the abundance of this species has increased in the Moksha River, likely due to a regular release of the juveniles into the Oka River (Lysenkov et al. 2006).

Family Esocidae

Esox lucius Linnaeus, 1758, Northern Pike.

Esox lucius Linnaeus 1758: 314—Kottelat and Freyhof 2007: 342.

Material examined. Table 1.

The only member of this family in European Russia; identified based on its long snout and large mouth. It is a widespread species in rivers and lakes but has been never recorded in karst and suffusion lakes. It is more fre-

Table 3. Share in catch and occurrence rate in different groups of water systems. Sh= share in catch; Oc= occurrence rate; and (+) = literature data. * Abundance of the Ukrainian brook lamprey was not surveyed.

	River sections at the indicated distances from the source, km								Streaming oxbows		Landlocked oxbows		Karst and suffusion lakes		Ponds		Water storage reservoirs	
	0–25		26–100		101–300		301–500											
	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %
Petromyzontidae																		
Eudontomyzon mariae		*		*														
Acipenseridae																		
Acipenser ruthenus						+		+										
Esocidae																		
Esox lucius	3.9	15.4	4.2	54.7	1	83.3	1.7	76.9	5.2	6.3	8.6	45.2			12.2	14.3	0.2	33.3
Cyprinidae																		
Abramis brama	0.3	2.6	0.5	5.7	1.8	41.7	3.5	46.2	5.8	37.5	3.9	16.1	3.7	16.7			10.3	33.3
Alburnoides rossicus	16.7	12.8	27.8	35.8	3.4	33.3	10	38.5										
Alburnus alburnus	8.3	28.2	20.1	100	40.2	100	41.3	100	3.6	50	9.1	22.6	1	8.3			6.8	100
Ballerus ballerus							0.3	7.7	0.7	12.5								
Ballerus sapa					0.3	16.7	0.9	23.1										
Blicca bjoerkna			4.8	20.8	4.4	50	7.3	53.8	7.1	62.5	1.6	32.3			0.9	3.6	0.6	33.3
Carassius carassius											12.1	25.8	65.4	25	5.6	17.9	11	66.7
Carassius gibelio	3.1	10.3	10.7	7.5							25.1	22.6	6.4	41.7	26.2	53.6	4.4	66.7
Chondrostoma variabile					0.8	41.7	3.1	38.5										
Cyprinus carpio								+		+			+				1.4	33.3
Rhynchocypris percnurus	5	5.1	9.2	1.9							16.1	32.3	98.1	25	91.7	14.3		
Gobio volgensis	22.8	53.8	7.4	73.6	6.7	83.3	3.6	53.8			1	3.2			13.5	3.6	5.9	66.7
Leucaspius delineatus	42.2	41	12.7	49.1	14.3	16.7	9.3	7.7	10.3	25	28.9	41.9	49	33.3	56.8	71.4	13.4	100
Squalius cephalus	5.4	10.3	4.6	41.5	8.6	66.7	5.1	53.8	0.3	12.5	1	9.7						
Leuciscus aspius			0.7	1.9	0.8	41.7	2.3	15.4	0.7	12.5	0.1	3.2						
Leuciscus idus	0.5	5.1	2.6	30.2	2	58.3	0.8	53.8	1.2	12.5	4.3	3.2	2.7	8.3			0.2	33.3
Leuciscus leuciscus	18.1	28.2	7.7	60.4	7.6	83.3	7.7	84.6	0.3	12.5					46.2	3.6		
Pelecus cultratus							0.4	15.4										
Rhodeus amarus	69.4	2.6	14.4	18.9	17.7	66.7	10.6	53.8			29.8	25.8			42.5	10.7	6	33.3
Romanogobio albipinnatus			7.7	5.7	4.5	58.3	6.3	61.5										
Rutilus rutilus	25.7	48.7	27.4	90.6	15.3	100	22.2	84.6	51	100	31.8	48.4	38.5	41.7	26.6	25	26.2	100
Scardinius erythrophthalmus	0.1	2.6	2.3	7.5	1.5	25	2.7	15.4	22.6	75	37.5	38.7	43.2	16.7			6.6	66.7
Tinca tinca									2.6	12.5	1.7	6.5			2.3	7.1	2.3	33.3
Nemacheilidae																		
Barbatula barbatula	42.7	76.9	13	56.6	1.2	16.7	2.2	15.4							0.4	3.6		
Cobitidae																		
Cobitis melanoleuca	13.4	41	7.3	37.7											0.4	3.6		
Cobitis taenia	5.0	30.8	4.7	54.7	0.9	41.7	2.6	23.1			1.6	3.2						
Misgurnus fossilis	5.4	10.3							49.8	25	9.2	16.1						
Siluridae																		
Silurus glanis			0.6	3.8	0.2	8.3	5.9	15.4										
Lotidae																		
Lota lota	4.2	10.3	1.5	18.9	1.6	8.3	2.4	7.7										

Continued

Table 3. *Continued.*

	River sections at the indicated distances from the source, km								Streaming oxbows		Landlocked oxbows		Karst and suffusion lakes		Ponds		Water storage reservoirs	
	0–25		26–100		101–300		301–500											
	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %	Sh, %	Oc, %
Percidae																		
Gymnocephalus cernuus	4.1	2.6	3.2	20.8	0.8	41.7	1.3	23.1	0.8	25	7.5	6.5					19.1	66.7
Perca fluviatilis	6.3	25.6	9.7	47.2	2.8	66.7	4.5	53.8	4.2	87.5	12.8	51.6	20.6	41.7	31.4	28.6	15.2	100
Sander lucioperca					0.2	8.3												
Sander volgensis							+											
Odontobutidae																		
Perccottus glenii	20.3	10.3	4.5	1.9					0.9	87.5	30.9	64.5	9.9	75	11.9	28.6		
Cottidae																		
Cottus koshewnikowi			0.3	1.9	+		+											
Number of species	23		27		26		28		17		21		11		15		16	
Number of individuals	2162		9843		4206		2860		1150		5932		1906		4429		2228	
Average number of species per one locality (min–max)	4.6 (1–10)		8.4 (3–15)		11.7 (5–20)		10.3 (4–18)		6.5 (4–10)		5.3 (2–10)		2.9 (1–5)		3 (1–5)		10 (6–14)	
Number of localities	39		53		12		13		8		31		12		28		3	

quently observed in rivers (15.4–76.9%) than other water bodies; and most frequently at a distance over 100 km from the source. In non-river habitats, the species is more frequently found in landlocked oxbows (45.2%).

Family Cyprinidae

Abramis brama (Linnaeus, 1758), Freshwater Bream.

Cyprinus brama Linnaeus 1758: 326.

Abramis brama—Kottelat and Freyhof 2007: 155.

Material examined. Table 1.

Presence of 23–30 branched anal-fin rays and 51–60 scales on lateral line. It was observed in all river types and other water bodies, except for ponds. It is rare in shallow rivers and its abundance is low; however, it is more common in larger rivers. *Abramis brama* is much more frequently found in floodplain lakes, flowing oxbows than in landlocked oxbows. It was found in reservoirs. *Abramis brama* is likely not native to the upper portions of the Moksha River, up to 25 km from the source, but rather it escaped from the constructed ponds in the upstream portions of the river.

Alburnoides rossicus Berg, 1924, Russian Schneider.

Alburnoides rossicus Berg 1924: 56—Bogutskaya and Coad 2009137.

Alburnoides bipunctatus rossicus Berg 1924: 56—Kottelat and Freyhof 2007: 159.

Material examined. Table 1; Fig. 6A.

The only representative of this genus in the Volga River drainage (Bogutskaya and Coad 2009), identified by a small black spot on each side of lateral line pore and 12–17 branched anal-fin rays. Although included in the Russian Red List since 2001 (Danilov-Danilyan 2001), it is still rather abundant in the Moksha River (Ruchin et al. 2007, 2009). This species lives only in rivers, and its abundance in the Moksha drainage increases forward to downstream (12.8% in the river on a distance of 26 km from the source up to 38.5% in the river from 301 to 500 km from the source); more abundant (35.8%) in the portion between 26 and 100 km from the source of river.

Alburnus alburnus (Linnaeus, 1758), Bleak

Cyprinus alburnus Linnaeus 1758: 325.

Alburnus alburnus—Kottelat and Freyhof 2007: 164.

Material examined. Table 1; Fig. 7C.

Presence of 45–48+3 lateral line scales; 17–20 branched anal-fin rays; and 16–22 gill rakers on first gill arch. It is an abundant species and is absent only in ponds; recorded in all sampled rivers at a distance of 26 to 500 km from the source. In upstream sections of rivers (up to 25 km from the source), its occurrence rate was 28.2%; in other water bodies, the rate varied from 16.1% in landlocked oxbows to 37.5% in flowing oxbows. The percentage of *A. alburnus* in catches increase with the size of the river, reaching 40% in sections of river between 200 and 500 km from the source. Its abundance in other water bodies is considerably smaller, about 1–9.1%.

Ballerus ballerus (Linnaeus, 1758), Zope.

Cyprinus ballerus Linnaeus 1758: 326.

Abramis ballerus—Reshetnikov et al. 2003a: 191.

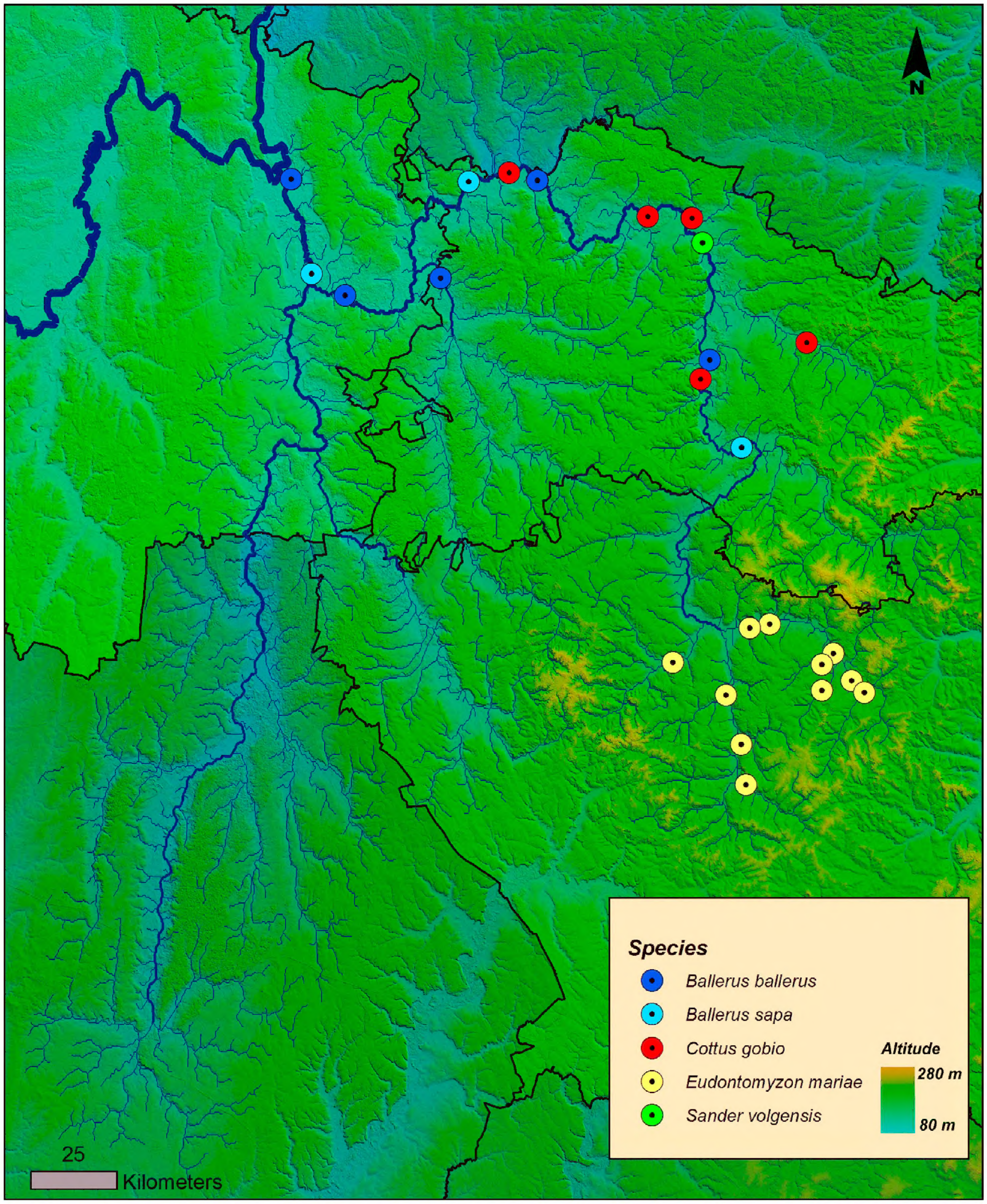

Figure 4. Map of occurrence of rare and restricted species, middle European part of Russia, Moksha river basin.

Ballerus ballerus—Kottelat and Freyhof 2007: 179.

Material examined. Table 1.

Presence of 33–34 branched anal-fin rays and upper position of the mouth. It is a rare species in the Moksha River (Fig. 4) and it was observed in the flowing oxbow lakes in the lower and middle portions of the river (12.5%), as well as in the middle and lower portion of the main river channel itself (7.7%). The share in catches is less than 1%.

Ballerus sapa (Pallas, 1814), White-eye Bream.

Cyprinus sapa Pallas 1814: 328.

Ballerus sapa—Kottelat and Freyhof 2007: 179.

Abramis sapa—Reshetnikov et al. 2003a: 195.

Material examined. Table 1.

Presence of 32–42 branched anal-fin rays and by the sub-terminal mouth position. It has been recorded only in the middle and lower portions of the Moksha River (Fig. 4). Its presence in catches and occurrence rate increase with the river size but is still insignificant.

Figure 5. Shoal of *Acipenser ruthenus* in the Moksha River at a depth of 10 m. Photo by diver I. Sibgatullin.

Blicca bjoerkna (Linnaeus, 1758), White Bream.
Cyprinus bjoerkna Linnaeus 1758: 326 .
Blicca bjoerkna—Kottelat and Freyhof 2007: 180.

Material examined. Table 1.

Presence of 19–23 branched anal-fin rays and subinferior mouth, which cannot be extended as a tube. The white bream has been observed in all types of water bodies, except in the smaller rivers (up to 25 km from the source) and the karst and suffusion lakes. The species reached the maximum occurrence 101–500 km from the source. In general, this species most frequently occurs in flow-through lakes and least frequently in ponds.

Carassius carassius (Linnaeus, 1758), Crucian Carp.
Cyprinus carassius Linnaeus 1758: 321.
Carassius carassius—Kottelat and Freyhof 2007: 144.

Material examined. Table 1.

Presence of a convex edge in dorsal fin and 23–33 gill rakers in first gill arch. This species avoids rivers, as well as is absent in the streaming oxbows connected to the rivers. This species is common in landlocked oxbows, karst and suffusion lakes, ponds, and storage reservoirs. It is most frequently found in storage reservoirs, which account for over 50%. The largest presence in the catch (65.4%) was recorded in karst and suffusion lakes.

Carassius gibelio (Bloch, 1782), Prussian Carp.
Cyprinus gibelio Bloch 1782: 71.
Carassius gibelio—Kottelat and Freyhof 2007: 145.
Carassius auratus gibelio—Reshetnikov et al. 2003a: 222.

Material examined. Table 1.

Presence of a concave border of dorsal fin and 37–52 gill rakers in first gill arch. This species used to be rarely captured in the 1960s (Dushin 1967), but is more frequently found nowadays, when compared to the congener *C. carassius*. The Prussian carp avoids large rivers (101–500 km from the source), as well as streaming oxbows. The occurrence in rivers farther than 100 km from the source is low, but abundant. The highest share in catches is recorded in landlocked oxbows and ponds; a high occurrence was observed in ponds and storage reservoirs.

Chondrostoma variabile Yakovlev, 1870, Volga Undermouth.
Chondrostoma variabile Yakovlev 1870—Kottelat and Freyhof 2007: 190.
Chondrostoma nasus—Reshetnikov et al. (2003a): 235, non *C. nasus* (Linnaeus, 1758).

Material examined. Table 1.

Presence of an arched mouth and 50–62 scales on lateral line. It is a frequent species, but rather abundant and was recorded only in rivers 101–500 km from the source.

Cyprinus carpio Linnaeus, 1758, Common Carp.
Cyprinus carpio Linnaeus 1758: 320—Kottelat and Freyhof 2007: 148.

Material examined. Table 1.

Presence of two pairs of barbels and 15–20 branched dorsal-fin rays. According to our observations, it was found only in storage reservoirs; however, artificial stocking of this species in ponds is known, as well as rare cases when it is caught in the Moksha River and its oxbows.

Gobio volgensis Vasil'eva, Mendel, Vasil'ev, Lusk & Lusková, 2008, Volga Gudgeon.
Gobio volgensis—Mendel et al. 2008: 1073.
Gobio gobio—Reshetnikov et al. 2003a: 250.

Material examined. Table 1.

Presence of two pairs of maxillary barbels, naked thorax between pectoral fins, and by the speckled dorsal and caudal fins. This species was recently recognized as valid, formerly considered junior synonym of *G. gobio* (Mendel et al. 2008), and inhabits rivers, ponds, and water reservoirs. In many shallow rivers, this species together *Barbatula barbatula* reach the upper streams. The share in catches decreases according to the increase in the river size. This species was rather common for rivers, accounting for over half of the cases in all types of rivers, and was rarely found and not abundant in landlocked oxbows.

Leucaspius delineatus (Heckel, 1843), Belica.
Squalius delineatus Heckel 1843: 1041.
Leucaspius delineatus—Kottelat and Freyhof 2007: 203.

Material examined. Table 1.

Presence of an incomplete lateral line with eight to twelve pored scales, superior mouth position and keel covered by scales between pelvic origin and anus. The belica inhabit all types of rivers and water bodies, being most frequently found in landlocked oxbows and ponds, and it was somewhat less frequent in karst and suffusion lakes. The highest share in catches was observed in the same water body types and rivers up to 25 km from the source. Note that most ponds are formed in these small rivers and most likely the pond populations assist in maintaining a high abundance of this species in very small rivers.

Leuciscus aspius (Linnaeus, 1758), Asp.
Cyprinus aspius Linnaeus 1758: 325.
Leuciscus aspius—Perea et al. 2010: 15.
Aspius aspius—Kottelat and Freyhof 2007: 177.

Material examined. Table 1.

Presence of an elongate maxilla reaching beyond anterior margin of the eye, and a symphysis on the lower jaw. *Leuciscus aspius* was absent in the upper portions

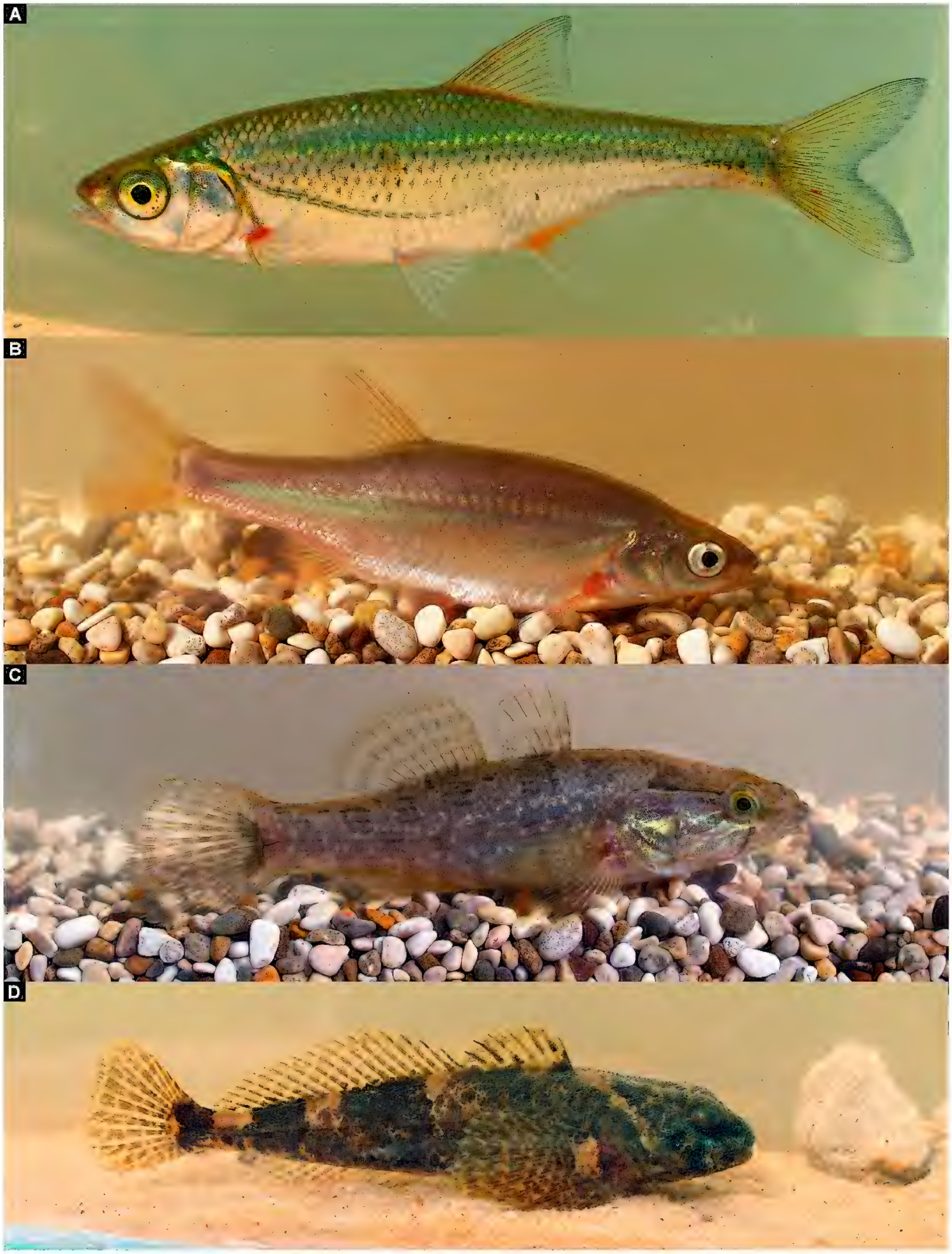

Figure 6. Ichthyofauna from the Moksha river basin. **A.** *Alburnoides rossicus*, 95.3 mm SL, P-197. **B.** *Rhynchocypris percnurus*, 91.3 mm SL, P-482. **C**. *Perccottus glenii*, 106.7 mm SL, P-482. **D**. *Cottus koshewnikowi*, 74.8 mm SL, released.

of rivers (0–25 km from the source) and attains the highest abundance in the river sections between 101–300 km from the source. This species was observed in the oxbows. The percentage in catches (2.3%) was observed in larger rivers (301–500 km from the source); in remaining cases, the occurrence was less than 1%.

Leuciscus idus (Linnaeus, 1758), Ide.

Cyprinus idus Linnaeus 1758: 324.

Leuciscus idus—Kottelat and Freyhof 2007: 206.

Material examined. Table 1.

Presence of a concave border on the anal fin and 56–58 + 3 scales on lateral line. It was recorded in all types of water systems, except for ponds. This species was most frequently observed in rivers, especially 101–500 km from the sources (over 50%). Its relative abundance in rivers was rather low (about 0.5–2.6%). Despite a low occurrence in landlocked oxbows, its share in catches was the highest one (4.3%).

Leuciscus leuciscus (Linnaeus, 1758), Common Dace.

Cyprinus leuciscus Linnaeus 1758: 323.

Leuciscus leuciscus—Kottelat and Freyhof 2007: 207.

Material examined. Table 1.

Presence of subequal jaws, and convex border of the anal fin. It was observed in all types of rivers, streaming oxbows, and in one pond (Artaev 2015). Its share in catches was the highest (18.1%) in rivers at a distance up to 25 km and decreases to a stable level about 7% downstream to a distance of 500 km. Mainly adult individuals was found in the upper reaches of rivers; the juveniles were not collected. This species is rare and in low abundance in flow-through lakes. Despite atypical in ponds, this species was however collected in one pond site (53.5779° N, 44.0143° E) with share catch about 46.2%.

Pelecus cultratus (Linnaeus, 1758), Sichel.

Cyprinus cultratus Linnaeus 1758: 326.

Cyprinus cultratus—Kottelat and Freyhof 2007: 219.

Material examined. Table 1.

Identified through the sabre-shaped body and the curved lateral line. It is a rare species for the Moksha River, and only solitary adult individuals were observed in the lower and middle reaches of the Moksha River.

Rhodeus amarus (Bloch, 1782), Bitterling.

Cyprinus amarus Bloch 1782: 52.

Rhodeus amarus—Kottelat and Freyhof 2007: 82.

Material examined. Table 1.

Presence of a sub-terminal mouth, and reduced body size (up to 95 mm SL). It was recorded in all types of rivers, landlocked oxbows, ponds, and storage reservoirs. According to the river enlargement, its occurrence rate increases to reach the maximum of 101–300 km from the source. In other water bodies, this species was most frequently observed in storage reservoirs and landlocked oxbows. Its highest share in catches was recorded in rivers up to 25 km from the source (Table 3); however, this value is determined by one case when this share reached 69.4% in a polluted river (Atmis River, near the Kevdo-Mel'sitovo village) in slowly flowing water. As for the remaining rivers, this species was not recorded, making this case rather than an exception. At a distance of 25 km from the source, its share in catches amounts to 10.6–14.4%, while the highest share was observed in ponds and lakes, and amounts to 42.5 and 29.8%, respectively.

Rhynchocypris percnurus (Pallas, 1814), Lake Minnow

Cyprinus percnurus Pallas 1814: 229.

Phoxinus percnurus—Reshetnikov et al. 2003a: 300.

Rhynchocypris percnurus—Kottelat and Freyhof 2007: 235.

Material examined. Table 1; Fig. 6, B

Presence of small scales and a pale yellow body color pattern. It was recorded in the northern portion of the Moksha River for the first time in 1978 (Potapov et al. 1998) in a pond of the Mordovskii nature reserve, although this species has long been observed in the adjacent Tesha River drainage (Puzanov et al. 1955). Currently, the lake minnow is widespread in the floodplain lakes and ponds along the Moksha River, and middle and lower reaches of the Vad River. The share in the catch in the karst and suffusion lakes, and in the ponds on the previously mentioned areas amounts 91.7–98.1%. As for landlocked oxbows, the share in the catch is considerably lower, 16.1%. This species was also recorded in a few shallow rivers running to the Moksha River with a share in the catch amounting to 5–9.2% (Satis and Ryabka Rivers).

Romanogobio albipinnatus (Lukasch, 1933), White-Finned Gudgeon.

Gobio albipinnatus Lukasch 1933: 57.

Romanogobio albipinnatus—Kottelat and Freyhof 2007: 101.

Material examined. Table 1.

Presence of white dorsal and caudal fins, and 42–43 + 2 lateral line scales. It was observed only in rivers, where it appears in 26–100 km from the source. Its occurrence increases with river enlargement from 5.7 to 61.5%; however, its share in the catch varies insignificantly (4.5–7.7%). This species is associated to larger rivers (Artaev and Ruchin 2013, Ruchin et al. 2008).

Rutilus rutilus (Linnaeus, 1758), Roach

Cyprinus rutilus Linnaeus 1758: 324.

Rutilus rutilus—Kottelat and Freyhof 2007: 246.

Material examined. Table 1; Fig. 7B.

Presence of red eye and ventral, anal and caudal fins, and by the terminal position of the mouth. The roach is the most abundant and frequent species in the Moksha River drainage. Its occurrence rate in rivers varies from 48.7% (in the regions to 25 km from the source) to 100% (200–300 km from the source). This species was recorded in all examined streaming oxbows and storage reservoirs, slightly less than half of the landlocked oxbows, karst, and suffusion lakes, and is least frequent in ponds (25%). The variation in its share in the catches in rivers of various sizes is insignificant (15.3–27.4%). The highest share in catches (51%) was observed in streaming oxbows, while the share in other types of water bodies varies in the range of 26.2–38.5%.

Scardinius erythrophthalmus (Linnaeus, 1758), Rudd.

Cyprinus erythrophthalmus Linnaeus 1758: 324.

Scardinius erythrophthalmus—Kottelat and Freyhof 2007: 252.

Material examined. Table 1

Presence of a red eye and ventral, anal, and caudal fins, superior mouth position and 9–12 gill rakers on first gill arch. It has been reported in all types of rivers and water bodies except for ponds; however, this species is

more abundant and frequent in the latter. The rudd fish is most frequent in the streaming oxbows (75% of the examined water bodies), as well as landlocked oxbows and storage reservoirs (38.7 and 66.7%, respectively), and least frequent in the karst and suffusion lakes. This species was observed in all types of rivers, but it is not abundant and has a low share in catches (0.1–2.7%). Its occurrence rate gradually increases according to the river enlargement, from 2.5% at 25 km from the source, to 15.4–25% at 101–500 km from the river source.

Squalius cephalus (Linnaeus, 1758), chub
Cyprinus cephalus Linnaeus 1758: 322.
Leuciscus cephalus—Reshetnikov et al. 2003a: 272.
Squalius cephalus—Kottelat and Freyhof 2007: 264.

Material examined. Table 1; Fig. 7A.

Presence of a convex border of anal fin, and by the orange to red color in the anal and pelvic fins. The chub inhabits all types of rivers and oxbows, and was absent in the karst and suffusion lakes, ponds, and storage reservoirs. This species was most frequently caught in rivers 26 to 500 km from the source, being the most abundant species (maximum share, 8.6%). The chub was more frequently found in flow-through lakes than in landlocked oxbows.

Tinca tinca (Linnaeus, 1758), Tench.
Cyprinus tinca Linnaeus 1758: 321.
Tinca tinca—Kottelat and Freyhof 2007: 296.

Material examined. Table 1.

Green pattern color of body and presence of small scales. This species does not inhabit rivers and has been observed only in other types of water bodies, except for karst and suffusion lakes. It most frequently inhabits reservoirs (33.3%) and streaming oxbow lakes (12.5%), with a slightly rarer occurrence in ponds and landlocked oxbows (7.1 and 6.5%, respectively). Its share in catches in all types of habitats varies in the range 1.7–2.6%.

Family Nemacheilidae

Barbatula barbatula (Linnaeus, 1758), Stone Loach.
Cobitis barbatula Linnaeus 1758: 303.
Barbatula barbatula—Kottelat and Freyhof 2007: 329.

Material examined. Table 1.

Presence of 15–16 branched caudal-fin rays and by the cylindrical body shape. It has been recorded in rivers of all types and river ponds. This is the most abundant species in shallow rivers, which inhabit the springhead of many rivers, frequently being the only representative of species of the fishes in such channel rivers. According to river enlargement, its occurrence rate and share in catches decrease, stabilizing at levels of 15.4–16.7 and 1.2–2.2%, respectively, 100 km from the river source. The stone loach abundance in ponds was low (0.4%), as well as its occurrence rate (3.6%).

Family Cobitidae

Cobitis melanoleuca Nichols, 1925, Siberian Loach.
Cobitis melanoleuca Nichols 1925: 3—Kottelat and Freyhof 2007: 309.

Material examined. Table 1.

Long and laterally compressed body shape and presence of two black spots on the caudal-fin base. It has been observed in rivers up to 100 km from the source. Its occurrence rate is rather stable with river enlargement (37.7–41%), while the share in the catch decreases from 13.4 to 7.3%. This species was rather rare in other types of water bodies; it was recorded only in one pond, where its share in the catch was less than 1%.

Cobitis taenia Linnaeus, 1758, Spined Loach.
Cobitis taenia Linnaeus 1758: 303—Kottelat and Freyhof 2007: 314.

Material examined. Table 1; Fig. 7D.

Long and laterally compressed body shape; presence of one black spot on the caudal-fin base. This species is morphologically similar to the Siberian loach, which inhabits rivers and is uncommon in other types of water bodies (recorded in only one landlocked oxbow). Unlike the Siberian loach, *C. taenia* was observed in all types of rivers. The abundance in rivers varies in the range 0.9–5% and the occurrence rate in the range 23.1–54.7%.

Misgurnus fossilis (Linnaeus, 1758), Weather Fish.
Cobitis fossilis Linnaeus 1758: 303.
Misgurnus fossilis—Kottelat and Freyhof 2007: 319.

Material examined. Table 1.

Presence of three pairs of barbels with four long barbel-like mental lobes and a cylindrical body shape. It was observed in muddy rivers to 25 km from the source and in oxbows. This species is most abundant and frequent in streaming oxbows.

Family Siluridae

Silurus glanis Linnaeus, 1758, Wels Catfish.
Silurus glanis Linnaeus 1758: 304—Kottelat and Freyhof 2007: 340.

Material examined. Table 1.

Presence of two pairs of mental barbels and 83–91 total anal-fin rays. This is the sole species of the family Siluridae in the Volga river drainage. According to our observations, it inhabits only rivers to 25 km from the source. Its abundance increased with river enlargement from 0.6 to 5.9%, and its occurrence rate from 3.8 to 15.4%.

Family Lotidae

Lota lota (Linnaeus, 1758), Burbot.
Gadus lota Linnaeus 1758: 255.
Lota lota—Kottelat and Freyhof 2007: 462.

Material examined. Table 1.

Presence of only one mental barbel, centralized, and pelvic origin anterior to pectoral-fin origin. It was recorded only in rivers; its share of the catch varies from 1.5 to 4.2%, and occurrence rate from 7.7 to 18.9%.

Family Percidae

Gymnocephalus cernua (Linnaeus, 1758), Ruffe.
Perca cernua Linnaeus 1758: 294.
Gymnocephalus cernua—Kottelat and Freyhof 2007: 528.
Gymnocephalus cernuus—Reshetnikov et al. 2003b: 62.

Material examined. Table 1.

Presence of two confluent dorsal fins, and body depth

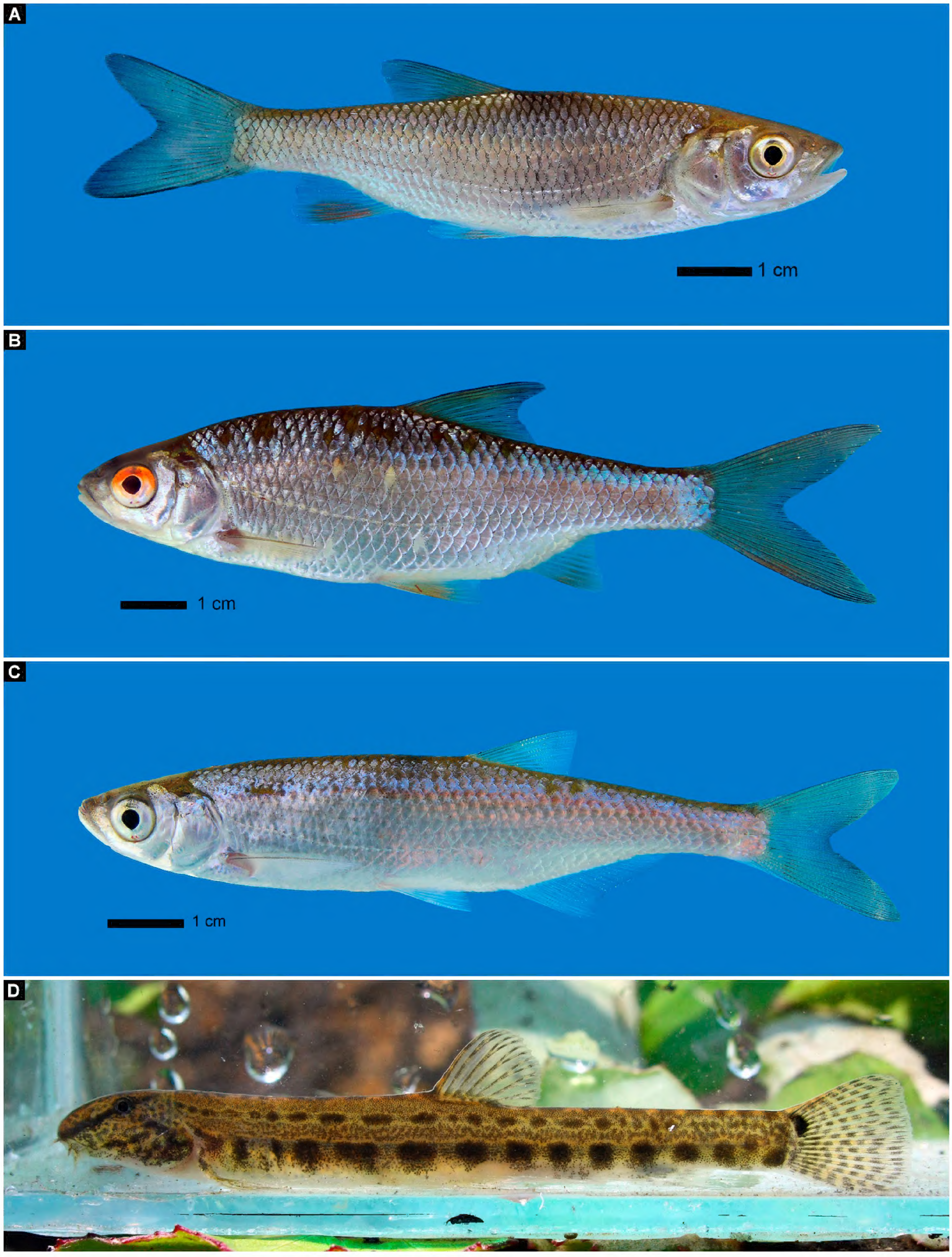

Figure 7. Ichthyofauna from the Moksha river basin. **A.** *Squalius cephalus*, 185.3 mm SL, released. **B.** *Rutilus rutilus*, 100.5 mm SL, released. **C.** *Alburnus alburnus*, 95.5 mm SL, released. **D.** *Cobitis taenia*, 102.2 mm SL, released.

24–27% SL. This species inhabits different size rivers, oxbows, and storage reservoirs, most frequently in rivers 101–300 km from the source (47.7%) and storage reservoirs (66.7%). In the latter, this species was most abundant in catches (19.1%).

Perca fluviatilis Linnaeus, 1758, European Perch.

Perca fluviatilis Linnaeus 1758: 289—Kottelat and Freyhof 2007: 530

Material examined. Table 1

Presence of dark blotch on posterior portion of dorsal fin, and five to eight bold dark bars on flank. It is a wide-

spread species, which was recorded in all types of water bodies. In rivers, this species is most frequent 100 km from the source and in other water bodies, in streaming oxbow lakes. Its share in river catches is low and varies from 2.8 to 9.7%, being approximately the same for the flow-through lakes. Such as for the remaining water bodies, its share in catches is higher, amounting to 12.8–31.4%, with a maximum in ponds.

Sander lucioperca (Linnaeus, 1758), Pike-perch.
Perca lucioperca Linnaeus 1758: 289.
Sander lucioperca —Kottelat and Freyhof 2007: 534.
Stizostedion lucioperca—Reshetnikov et al. (2003b): 69.

Material examined. Table 1

Presence of spindle-shaped body, canine teeth in the anterior portion of each jaw, and 80–97 scales on lateral line. It was observed in large rivers 100 km from the source (Ivanchev and Ivancheva 2010). Its occurrence rate is 8.3% and the share in catches is low.

Family Odontobutidae

Perccottus glenii Dybowski, 1877, Chinese Sleeper.
Perccottus glenii Dybowski 1877: 28—Kottelat and Freyhof 2007: 549.

Material examined. Table 1; Fig. 6C.

Presence of two dorsal fins without spines, first and second dorsal fin with six to eight unbranched rays, and second dorsal fin with eight to 12 branched rays. This is an invasive species, first found in 1979 (Potapov et al. 1998). It was recorded in small rivers (to 101 km from the source) and all other types of waterbodies, except for storage reservoirs. Its highest occurrence rate was observed in oxbows as well as karst and suffusion lakes (75–87.6%). Its occurrence rate in ponds is moderate (28.6%), and in rivers, low (10.3%; rivers to 25 km from their source); or very low (1.9%; rivers at 26–100 km from their source). The highest abundance was observed in landlocked oxbows, where its average share in catches is 30.9%.

Family Cottidae

Cottus koshewnikowi Gratzianov 1907, Volga Sculpin.
Cottus koshewnikowi Gratzianov 1907: 658—Kottelat and Freyhof 2007: 511.
Cottus gobio—Reshetnikov et al. 2003b: 163, non *C. gobio* Linnaeus, 1758.

Material examined. Fig. 6D.

Presence of 1 lower jaw pore, and incomplete lateral line usually with 17–25 pores. This is the only species of the genus *Cottus* in the Volga river drainage. It is a rare species, inhabiting only rivers system. Five localities are known to the distribution of this species and are shown in Fig. 4 (Artaev and Ruchin 2015), one of them (Fig. 4, easternmost point) housing a stable population; the remaining cases represent solitary catches.

Discussion

Moksha River drainage is inhabited by 37 species of fish herein recorded, in which 34 of them recorded in river ecosystems and 26 in lake habitats.

The stream volume had a rather insignificant effect on the number of species observed in the examined group of rivers. The number of species in catches increases according to the enlargement of the river, reaching a plateau of 10–11 species in the river sections over 100 km from the source. The occurrence rates of *Abramis brama*, *Blicca bjoerkna*, *Squalius cephalus*, and *Silurus glanis* showed a distinct trend of an increase with the stream size (distance from the source); *Barbatula barbatula* showed a distinct opposite trend (decrease in occurrence rate with distance from the source). Some species, such as *Acipenser ruthenus*, *Ballerus sapa* and *Chondrostoma variabile*, occur in larger rivers, whereas others such as *Rhynchocypris percnurus*, *Carassius gibelio*, *Perccottus glenii*, *Misgurnus fossilis* and *Cobitis melanoleuca* are absent in larger streams. The first four species do not inhabit larger rivers, they are limnophilic species. The presence of limnophilic species in small rivers could be most likely explained by the fish escaping from ponds in small streams. Most species showed an increase in occurrence rate with the enlargement of the river and its stabilization occurs at a distance exceeding 100 km from the source.

The richest species composition among the remaining examined groups of water bodies was found in landlocked oxbows, including 21 species, and the poorest were found in karst and suffusion lakes (11 species). In general, the largest number of species was recorded in the oxbows, which can be explained by their tight association with the river floodplain formed during the spring floods. A comparison of landlocked and streaming oxbows showed that the former has a larger number of species. Presumably, this is determined by more diverse conditions in the landlocked oxbows, including different areas, depths, association with an open or a closed part of the floodplain, as well as different oxygen regimes, which change depending on the presence of underwater springs. An average of 6.5 species is present in one catch from streaming oxbows versus 5.3 species in landlocked oxbows. Presumably, this difference is explainable by the group of landlocked oxbows including small water bodies, subject to suffocation, which contain only two species each. The karst and suffusion lakes originated and are located independently of the river network, allowing fish migration; most of these water bodies are isolated from rivers, determining their poor ichthyofauna (12 species). Ponds and storage reservoirs are artificial water bodies formed by damming of a stream; they differ in the size of the dammed water flow: ponds are formed on shallow rivers and brooks, storage reservoirs on larger rivers. Despite this difference, the number of species living there is equal; however, three species on the average were present in one pond locality versus ten species in storage reservoirs. A larger number of species in each storage reservoir could be explained by their ichthyofauna being formed by larger rivers, which is richer in species composition and in some cases, additionally by floodplain water bodies, as well as their larger sizes, resulting in a higher diversity in biotopes.

The following species can be regarded as rare for the Moksha River drainage: *Acipenser ruthenus*, *Cyprinus carpio*, *Pelecus cultratus*, *Sander volgensis*, and *Cottus gobio*. *Perccottus glenii* (recorded for the first time in 1979) and *Rhynchocypris percnurus* (recorded for the first time in 1978) are invasive species in this river basin (Potapov et al. 1998).

This was the first study to comprehensively analyzing the ichthyofauna of Moksha river basin, and the results of this study revealed two species previously unreported for Moksha river, *Romanogobio albipinnatus* and *Cobitis melanoleuca*, in which previous studies could not differentiate it from closest related species (Dushin 1967, 1978). In our study we could not capture *Acipenser ruthenus* although we had evidences in the Moksha river by fishermen's catches data and underwater pictures divers (Fig. 5); and *Sander volgensis* was only recorded from literature (Lysenkov et al. 2010).

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